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BULLETIN OF THE RESEARCH COUNCIL OF ISRAEL

Section B
ZOOLOGY

Bull. Res. Counc. of Israel. B. Zoology

The Weizmann Science Press of Israel • Jerusalem • ירושלים • מוסד ויצמן לפרסומים במדעי הטבע ובטכנולוגיה בישראל

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THE BIOLOGY OF THE CICHLID FISHES OF LAKES TIBERIAS AND HULEH

ADAM BEN-TUVIA

Sea Fisheries Research Station. Haifa, Israel

ABSTRACT

Several species and subspecies of cichlid fish were investigated during the period of 1950–1951. The life histories of the following fishes from Lake Tiberias were studied: *Tilapia galilaea, Tilapia nilotica, Tilapia zillii, Tristramella simonis simonis and Tristramella sacra.* In Lake Huleh only *Tristramella simonis intermedia* was studied.

The spawning season of cichlids seems to be similar for all species examined. It starts at the end of March or beginning of April and in most of the species extends until June, July or August. In *Tristramella simonis simonis* it continues until the end of August.

With the exception of *Tilapia zillii,* all the local cichlids are mouth breeders. In *Tilapia galilaea, Tristramella sacra* and *Tristramella simonis intermedia* both sexes brood their eggs while in *Tilapia nilotica* and *Tristramella simonis simonis,* brooding is by females only.

The number of eggs in the ovaries was counted and the diameter of the eggs measured. An attempt was made to establish the number of fry bred by a single fish.

The rate of growth is rapid in *Tilapia galilaea*; at the end of the first year of life the fish attains an average length of 138 mm in males and 140 mm in females. At the end of the second year the fish attains 227 mm (males) and 224 mm (females). Fishes above 330 mm in length are mostly males of five to seven years. *Tilapia galilaea* spawns for the first time after reaching a total length of 180 mm. A slightly slower rate of growth was found for *Tilapia nilotica* which also matures at the same size as *Tilapia galilaea.* Other species of cichlid fish grow at a much slower rate and spawn when 13–15 cm long.

The relationship between length and weight of *Tilapia galilaea* was calculated. It was found that the condition factor K is higher in fish caught during the months January-May than during the months June-August.

The food of cichlids consists mostly of phytoplankton; zooplankton and higher plants occur in small quantities. *Tristramella sacra* is a plankton feeder also, and not a predator as described in the previous literature on the cichlids of Lake Tiberias.

A key, for the determination of cichlids in Israel was prepared, including *Tristramella simonis intermedia,* a form peculiar to Lake Huleh.

INTRODUCTION

General information

An adequate knowledge of the biology of cichlids was necessary for the development and management of the fisheries in Lake Tiberias and Lake Huleh. Fishes of this family are caught in considerable quantities, and are highly prized as food, bringing high prices on the local markets.

From a scientific point of view the breeding habits of cichlids are of special interest.

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All species of this family take great care of their young and in most of them the eggs are carried and hatched in the mouth. The mouth breeding and the behavior of the matched pair are associated with complex instinctive processes (in many ways resembling the egg breeding habits of birds) and have been the subject of several investigations (Boulenger 1908, Aronson 1949, Bearends and Baerends — van Roon 1950, Lowe 1955 b).

The literature dealing with cichlids in this country is concerned chiefly with systematic and zoogeographical problems (Tristram 1884, Barrois 1894, Annandale 1913, Regan 1924, Vinciguerra 1926, Gruvel 1931, Steinitz 1951, 1954). The paper of Trewavas (1942) was especially useful in clarifying the systematic position of cichlids in Palestine.The biological papers are few and limited mostly to the reproductive behavior of the different species (Lortet 1875, Pellegrin 1903, Bodenheimer 1927, Liebman 1933).

Development in cichlid fish culture in Southeast Asia and in Africa shows that some species grow rapidly and may constitute an important element in intensive fish breeding (Atz 1954, Chimits 1955, 1957). In order to determine the possibilities in this country, experimental rearing of *Tilapia galilaea* was started in artificial ponds near Ginossar (Ben-Tuvia and Hofenberg 1950). It was shown already during the first year of the experiments, which started in May 1950 and ended in March 1951, that this fish can be bred succesfully in fresh water ponds. These experiments were continued and also extended to other species of *Tilapia* in ponds of Ginossar, Sdeh Nahum and Dor (Reich 1954, Sarig 1955, Yashouv 1956, 1958).

Excellent results were obtained in monosex culture of *Tilapia*, especially with hybrids (Hickling 1959). In most of the species males grow faster than females and give a better yield in ponds. The average growth seems to be more rapid in both sexes when no reproduction takes place. In a well planned fish pond the possibility of controlling the rate of reproduction eliminates the danger of overcrowding. Due to the external difference in the sex organs (Lowe 1955a) young males and females can be differentiated and hence separated. The same differences in the appearance of genital papilla were found in *Tilapia galilaea* and *Tilapia nilotica* of Israel.

The great advantage of most of *Tilapia* species is their resistance to changes in salinity. Talbot and Newell (1957) working in Zanzibar, transfered species of *Tilapia* from a fresh water stream to a sea water pond after keeping them for a short period of time in an aquarium tank to which salt was gradually added. The fish not only grew in the salt water ponds but also reproduced. King and Wilson (1951) found that *Tilapia mossambica* can be adapted to salinities of the sea water if transfered gradually from a fresh water medium. Zarka (1956) found that *Tilapia zillii* in Egypt is able to survive salinities as high as 29 ‰; *Tilapia nilotica* and *Tilapia galilaea* are more vulnerable to high salinities but still can live in brackish water.

Many facts indicate that cichlids are rather sensitive to changes in temperature. During the exceptionally cold days of 2–4 of February 1950 when snow fell in Tiberias, many specimens of cichlids were found dead along the shores of the Lake. Very low

temperatures in winter may cause a considerable mortality in ponds where *Tilapia nilotica* and *Tilapia galilaea* are kept. Information from the fish-breeders of Kibbutz Maayan Zvi indicate that there was high mortality among the fish kept in the ponds of the Kibbutz during December 1958 when both cold weather and a strong wind prevailed.

According to Ricardo-Bertram (1942) about 30 tons of dead cichlids were collected from Lake Huleh during the exceptionally cold winter months of 1941/1942, when the lowest recorded water temperature near the eastern shore was 9°C. These were mostly large fish.

THE FISHERY

Cichlids are important in the fishery of the Jordan Valley. The fish of this family constitute an average of 20.7 ‰ of the total catch of Lake Tiberias during the years 1950–1957 (Table I). Their relative commercial importance was even higher in Lake Huleh where the average catch of cichlids during the same period amounted to 45.2 ‰ of the total catch. The drainage work which started in year 1956 brought great changes in the yield from Lake Huleh. The catch of cichlids decreased considerably in the year 1957 and amounted to only 17.37 tons (10.1 ‰ of the total catch). *Tristramella simonis intermedia* disappeared completely during the year 1958.

Two papers have been published on the fishery of Lake Tiberias; Hornell (1935) gives an extensive report on the fisheries and fishes of Palestine which includes also a survey of cichlid fishes; Ricardo-Bertram (1944) who investigated the fisheries of Lake Tiberias from December 1940 to April 1942 published conclusions and recommendations which were instrumental in the substantial improvement of the cichlid fishery in the Lake. In former years the cichlids were overfished mainly due to the heavy fishing of small *Tilapia*. In order to prevent the inclusion of undersized fish in the catch, a larger mesh was introduced (45 mm knot to knot in trammel net for cichlid fish). Due to this, only mature fish of minimum size 18 cm were caught (Ricardo-Bertram 1944) and after a few years the total catch of cichlids and their average size greatly increased.

Among the six species known in Lake Tiberias five of them are of economic importance. *Tilapia galilaea* is the most important fish constituting 50–65 ‰ of all the cichlids. *Tristramella simonis simonis* occupies the second place and *Tilapia nilotica* the third. Two other species, namely *Tilapia zillii* and *Tristramella sacra* are of little commercial value. Statistical data published (Statistical Bulletin 1949–1957) are given only for *Tilapia galilaea*, *Tilapia zillii* and *Tristramella simonis*. Other species are not mentioned explicitly but are included among the three others (Table III). Separate data (Statistical Abstracts 1937–1941) on the catch of each species are given (Table II). This data for the years 1936–1940, shows that *Tilapia galilaea* comprises an average of 49.4 ‰ of the toatl catch of cichlids. According to my observations for the years 1950–1952 the make-up of the catch is similar to

TABLE I

Catch of cichlids and other fish from Lake Tiberias, Lake Huleh and the Jordan River during the years 1949/50–1957. Weights in metric tons.

Year	Catch in Lake Tiberias				Catch in Lake Huleh				Catch in Jordan River				Total for Tiberias, Huleh and Jordan			
	Cichlids	Other fish	Total	% of cichlids	Cichlids	Other fish	Total	% of cichlids	Cichlids	Other fish	Total	% of cichlids	Cichlids	Other fish	Total	% of cichlids
1949/50	133.833	436.067	569.900	23.5	62.176	39.124	101.300	61.4	7.268	5.932	13.200	55.0	203.277	481.123	684.400	30.0
1950/51	93.361	587.839	681.200	13.7	83.288	51.512	134.800	61.8	9.404	2.796	12.200	77.1	186.053	642.147	828.200	22.5
1951/52	207.222	745.978	953.200	21.7	88.552	63.448	152.000	58.3	15.289	9.711	25.000	61.2	311.063	819.137	1130.200	27.5
1952/53	85.268	542.432	627.700	13.6	72.790	49.010	121.800	59.8	9.196	1.904	11.100	82.8	167.254	593.346	760.600	22.0
1953/54	196.937	637.863	834.800	23.6	56.113	71.687	127.800	43.9	9.340	3.560	12.900	72.4	262.390	713.110	975.500	26.9
1954/55	86.170	634.230	720.400	12.0	64.617	81.183	145.800	44.3	10.138	1.262	11.400	88.9	160.925	716.675	877.600	20.7
1956	156.856	684.744	841.600	18.6	63.672	106.628	170.300	37.4	18.299	1.001	19.300	94.8	238.827	792.373	1031.200	23.2
1957	342.186	730.814	1073.000	32.0	17.370	154.130	171.500	10.1	37.800	7.500	45.300	83.4	397.356	892.444	1289.800	30.8
Yearly average	162.729	624.958	797.937	—	63.572	77.090	144.125	—	14.591	4.208	18.800	—	240.893	706.294	947.187	—
Yearly % of total catch	20.7	79.3	100%	—	45.19	54.81	100%	—	77.6	22.4	100%	—	25.43	74.57	100%	—

TABLE II

Catch of cichlid fish from Lake Tiberias, Lake Huleh and Jordan River during the years 1936/7–1940/41. *Weights in metric tons.*

Year	*galilaea*	*nilotica*	*zillii*	*simonis simonis*	*sacra*	*simonis intermedia*	Total cichlids
1936/7	59.793	8.136	0.762	7.290	1.119	39.255	116.355
1937/8	46.818	0.402	3.004	8.741	0.090	30.799	95.854
1938/9	38.040	2.520	0.825	10.886	5.151	15.516	72.938
1939/40	51.116	1.604	1.545	4.008	1.266	32.297	91.836
1940/41	48.418	2.835	2.865	10.107	2.280	50.562	117.067
Mean yearly catch	48.837	3.099	3.000	8.206	1.981	33.686	99.000
Percentage	49.4	3.1	3.0	8.3	2.1	34.1	100%

TABLE III

Cath of cichlid fish from Lake Tiberias, Lake Huleh and Jordan River during the years 1949/50–1957. *Weights in metric tons.*

Year	*galilaea* (and *nilotica*)	*zillii*	*simonis simonis* (and *sacra*)	*simonis intermedia*	Total cichlids
1949/50	129.805	2.308	17.808	53.356	203.277
1950/51	91.238	3.663	9.337	81.815	186.053
1951/52	193.118	1.174	32.943	83.828	311.063
1952/53	92.159	1.518	16.482	57.095	167.254
1953/54	225.675	1.736	17.507	18.202	263.120
1954/55	127.650	0.454	16.783	16.055	160.942
1955/56	165.578	0.300	38.780	34.198	238.856
1956/57	372.005	0.150	33.539	13.828	419.522
1957/58	311.132	0.595	39.688	0.495	351.910
Mean yearly catch	189.817	1.322	24.763	39.874	255.777
Percentage	74.2	0.5	9.7	15.6	100%

that of the years 1936–1940, except for the percentage of *Tristramella sacra* which seems to be even less now than during the previous period.

The remaining species, *Haplochromis flavii-josephii* hardly ever appears in the commercial catch since it is too small to be retained by the mesh. Nevertheless, it may have a certain influence on the biology of cichlids as a competitor for food and spawning places in the lake. This small fish lives in the shallow water along the shores and like most of the cichlids is a mouthbreeder.

The economic importance of the various cichlid species in Lake Huleh and Lake Tiberias differs greatly. *Tristramella simonis intermedia* was the most common fish in Lake Huleh and probably the species best adapted to the local conditions. About 70‰ of the catch of cichlid fish consisted of this species during the years 1950–56;

the remaining species were decidedly less important, *Tilapia nilotica* occupying second place and *Tilapia galilaea* third. *Tilapia zillii* was comparatively rare and the remaining species *Tristramella sacra* and *Haplochromis flavii-josephii* were unknown in Lake Huleh (Steinitz 1951 a).

All the commercial species of cichlids in the Lake of Tiberias feed chiefly on phytoplankton which seems to be very abundant at certain seasons of the year (Komarovsky 1959). The amount of available food is probably not a limiting factor in the fish production. On the other hand, the comparatively small number of eggs bred and the special requirements for suitable spawning grounds suggest that it may be profitable to protect the fish, by restricting fishing during April and May, the peak of the spawning season. Protection of spawning and brooding fish was suggested by Lowe (1952) as a method of conservation of *Tilapia* populations in Lake Nyasa. Another possibility of increasing the population of cichlid fishes of commercial importance is by rearing them in artificial ponds and releasing the young fish into the lake. This method was first started in 1950 with *Tilapia galilaea* which reproduces easily in ponds (Ben-Tuvia and Hofenberg 1951). After attaining the size of 6–12 cm the fry were successfully transplanted into the lake. There is some evidence that after transfer the mortality rate of fishes reared under these conditions is low.

Because of the intensive fishery of cichlids in Lake Tiberias there is a danger of overfishing. Graham (1929) gives several examples of a harmful influence of irrational fishing on the stock of *Tilapia* in Lake Victoria.

The introduction of *Tilapia melanopleura* to Israel was suggested by Hofstede (1955) since this species is a plant eater and may be useful for removing submerged aquatic plants in ponds. However, the local species, *Tilapia zillii* has habits similar to those of *Tilapia malenopleura*, feeding to a large extent on aquatic vegetation. In fact Daget (1956) considers it closely related to *Tilapia melanopleura*. In addition, two other local species, *Tilapia nilotica* and *Tilapia galilaea* appear to be suitable for pond culture (Ben-Tuvia and Hofenberg 1951, Reich 1954, Sarig 1955, Yashouv 1956 and 1958) and grow in this country as fast as *Tilapia melanopleura* in Africa (De Bont 1954, Lowe 1955a, Huet 1957).

The problem of the introduction of *Tilapia mossambica* into the water basins of Central America has been discussed by Myers (1955) and by Drake (1955). Their arguments against the introduction of foreign species are equally valid for Israel.

MATERIAL AND METHODS

The work described in this paper was begun in February 1950 and concluded in August 1951. Most of the data was reviewed and summarized in a paper published in Hebrew (Ben-Tuvia 1953). The publication of the English version was considerably delayed and it was found necessary to widen the scope of the paper by considering literature and data which have accumulated since. This has only been partly accomplished however, since the author is no longer working in the field of fresh water fishes.

Most of the material for the present work was obtained from the co-operative

sh storehouse in Tiberias; the rest, directly by examination of the catch of the shermen in their boats. The fishes were caught by the usual methods employed in ,ake Tiberias (trammel nets with mesh of 45 mm knot to knot, beach seine net of 5 mm mesh and cast-net of 35 mm mesh). The fish caught by these nets are usually ver 16 cm in total length. In order to collect smaller fishes, a dip-net and a cast-net vere used with a mesh of 7–10 mm from knot to knot of the type used for catch of Tiberias sardine" (*Acanthobrama terrae-sanctae*).

Most of the fishes collected for the present study were caught in Lake Tiberias. ome were collected from the Jordan River in the section between Deganiah and eth Zerah, and the specimens of *Tristramella simonis intermedia* came from Lake Iuleh. Length measurements were made in the cold-store house. All other measure-nents, weighings, dissections of fish, collection of otoliths and scales were carried ut in the Tiberias laboratory of the Division of Fisheries. The reading of the otoliths nd scales, the counting of the eggs in the ovaries, the measurement of the diameter f the eggs and the examination of the stomach contents were made in the laboratory f the Sea Fisheries Research Station. If not otherwise stated the length measurements re given as total lengths. Each fish was measured to the nearest half centimetre.

ACKNOWLEDGEMENT

I wish to express my deep appreciation to the late Dr. H. Lissner, formerly Director f the Sea Fisheries Research Station whose help, based on his vast scientific experience ontributed very much to the present investigation.

I am indebted to Prof. H. Steinitz of the Hebrew University for his interest and elp. My thanks go to Mr. Bar-Ilan, the Director of the Fisheries Office in Tiberias or his encouragement and assistanca in putting at my disposal his staff and the oats of the Division of Fisheries; to Dr. G. Paiser for his help in mathematical alculations; Prof. K. Reich of the Hebrew University for his kind suggestions after eading the manuscript; to Dr. B. Komarovsky, my colleague at the Sea Fisheries Reasearch Station for the determination of the plankton in the food of the Cichlidae.

LIFE HISTORY OF CICHLIDS

Tilapia galilaea

This fish is known in this country by two common names: Amnon hagalil (Hebrew); Musht abiad (Arabic).

1. *Reproduction*

At the end of the winter season (during March) the large schools of *Tilapia galilaea* disperse and pairs begin to appear near the shores in search of suitable spawning places. The fish prefer to spawn in shallow water, rich in plants where the bottom is covered by sand and gravel. The place chosen for spawning is levelled by the pair and the female lays her eggs, which are immediately fertilized by the male. After this,

both male and female take the eggs into their mouths, keeping them there, un the end of their larval development (absorption of the yolk sac). The first to descri the breeding behaviour of *Tilapia galilaea* was Pellegrin (1905). Later the spec was studied by Bodenheimer (1927) and Liebman (1933) who reported that bo the male and the female participate in mouth breeding. This fact was confirmed the author; 49 mouth breeding specimens were examined; 35 (71.4‰) of which we females and 14(28.6‰), males. Assuming that there are equal numbers of males an females in the lake, the difference between the number of breeding males and femal is statistically significant. The hypothesis of equal numbers of males and females wa confirmed by the examination of 448 specimens of which 230 were males and 2 were females, a ratio of 1.05: 1. Thus it has been shown that the males do participa in mouth breeding but to a lesser extent than the females. Data from the Africa lakes (Lowe 1955, Greenwood 1957) indicate that in this region mouth breeding ha been observed only in the female. Thus mouth breeding in the male may be a featu peculiar to the population of *Tilapia galilaea* in Israel.

The spawning season begins at the end of March or the beginning of April an continues until mid-August. Throughout this long period, the fish can be found wi eggs in their mouths. An investigation of a large number of the fish caught in La Tiberias shows that the most intensive spawning occurs during the first months the reproductive period, i.e. in April, May and the first half of June. It is much le prevalent during the remaining months of the reproductive season.

It appears that the spawning is affected by the weather. The temperature at th end of the winter may especially influence the beginning of the reproductive seaso This was illustrated by the fact that in 1950 the spawning started at the end of Apri probably as a result of the cold and rainy winter (snow in February at Tiberias whereas the winter of 1951 was characterized by high temperatures and scarcity o rain and the fish began to breed at the end of March. Observations made in Lak Tiberias indicate that spawning is accelerated during the days of the heat wave known as "Chamseens". At this time *Tipapia galilaea*, in larger numbers than usual approach the shores where they are caught in great quantities by the fishermen.

The reproductive season has been determined by two distinctive features:

a) the appearance of eggs and larvae in the mouths of the breeding fishes,

b) the presence of ripe females (the eggs being expelled by a light pressure along th belly of the fish).

According to Ricardo-Bertram (1944) the spawning season lasts from Decembe to May with the peak in March and April. My own observations are not in accordanc with her findings. In spite of the large number of specimens examined, no singl instance of spawning before March was found. Undoubtedly, spawning also continue during the months of June, July and August.

It should be pointed out that the peak of the spawning of *Tilapia galilaea* occur simultaneously with the maximum height of the water level of Lake Tiberias whic takes place in May (Oren 1957).

The rising of the water level of Lake Tiberias probably has a decided influence on the development of the young fish. The water covers the stretch of land along the shores and forms large ponds rich in vegetation, an excellent nursery ground for the young cichlid fishes. The temperature in such pools is usually high and beneficial for the development of the fry, and the shallow water protects them from pursuit by the larger fish. It is interesting to note that an indication of increased breeding of cichlids during rainy seasons was observed by Lowe (1956) in Lake Victoria.

The sexual glands of *Tilapia galilaea* are paired and more or less symmetrical. The ovaries are posteriorly joined together by a short common duct which leads to the outside, ending with a small genital papilla. The ovaries contain a small quantity of eggs and even at the time of sexual maturity they do not occupy the entire length of the abdominal cavity.

The following are the six stages of development in the maturation of the ovaries of *Tilapia galilaea* which were used in this study:

The gonads form two thin, transparent strips; ovaries and testis can not be differentiated by the naked eye. This stage is characteristic of young fish smaller than 10 cm total length.

The ovaries are still thin but small eggs are already visible. This stage is peculiar to fish from 10 to 17 cm.

The ovaries are larger and contain yellow eggs of different sizes, but whose diameter does not exceed 1.8 mm.

The ovaries are developed and full of greenish eggs whose diameters range from 1.8 mm to 2.2 mm; among them are small, white eggs 0.4 to 1.4 mm in diameter. This stage is characteristic of adult fish (17 cm length and over) preparing to spawn.

a. The ovaries are similar to those of stage 4, but the appearance of larvae in the mouth of the female, indicates that the fish has already spawned once and is preparing to spawn again.

Spawning stage: the mature eggs are large and green. They can be expelled by a slight pressure along the abdomen.

A short transitional stage, immediately after the spawning; the ovaries contain small white eggs and occasionally partly dissolved remnants of the large green eggs. The membrance of the ovaries is covered by prominent blood vessels.

Pellegrin (1905) and later Liebman (1933) pointed out that the ovaries are quickly replenished after spawning and that there is a possibility of additional spawnings in the same season. Females still carrying larvae in their mouths have again already fully developed ovaries. Accurate measurements of the eggs in the ovaries at different stages of development and during various periods of the year indicate that *Tilapia galilaea* lays eggs more than once in a spawning season in Lake Tiberias. Lowe (1955a) assumes that *T. galilaea* and *T. nilotica* of East Africa have three, four or more batches of young in succession. It has been found that the diameter of eggs in the ovary of females still keeping their young in their mouths, is often larger than the diameter of eggs of adult fishes during November and December (stage 4a). In such cases the

ovaries of the still breeding fish were in a stage of advanced development simil to stage 4.

The eggs are oval shaped and their longitudinal axis (length) and transversal ax (width) were measured at various stages of the development of the ovaries.

TABLE IV

Diameter of eggs in ovary of Tilapia galilaea

Stage of Maturity	Width (in mm)	Length (in mm)	Average Width	Average Length
4	1.35–1.80	1.70–2.40	1.48	1.93
4a	1.47–2.10	1.83–2.44	1.65	2.08
5	1.88–2.26	2.33–3.05	2.08	2.63

The number of eggs in the ovaries was determined by counting a sample of 2–5 g (1/6–1/10 of the total weight of the ovaries) and calculating the relation of the weig of the samples containing a known number of eggs to the weight of the whole ovar

In some cases the total number of eggs in the ovaries was obtained by measureme of volume, instead of weight. The difference in results for the two methods did n exceed 100 eggs. Eggs of almost ripe females in stage 4 were counted. Only la eggs whose diameters were greater than 1.7 mm were taken into account; very sm eggs which probably do not leave the ovary during the process of egg-laying w not counted.

TABLE V

Relation between size of fish and number of eggs in ovaries

Total length of fish (in cm)	Number of species examined	Number of eggs in ovaries	Average number of eggs in ovaries
18–21	5	770–1350	1093
25–26	8	2394–3300	2757
28–32	10	3100–5010	4340

The number of mature eggs varied according to the size of the fish; the ovaries c small females contain less eggs than the ovaries of larger ones.

When captured by the net the breeding fish expels some of the eggs from its mout and occasionally swallows some. It is, therefore, difficult to determine the exac number of eggs carried in the oral cavity. Twenty-eight breeding fish were examine and were found to carry from 150 to 1086 eggs or larvae, usually between 600 and 70(The number of eggs in large fish was generally higher than that in smaller one: No difference could be seen between males and females in the number of eggs carriec It was found that the number of offsprings in the mouths of the breeding parent was between 600 and 1086 for each fish. Assuming that the fish spawn at least twic in a season, and each of the parent fish breed between 600 and 1100 eggs, the repro

uctive rate for a pair of *Tilapia galilaea* in one season will be from 2400 to 4400 eggs. It is even possible that the fish spawn more than twice in one season.

The eggs completely occupy the mouth of the breeding fish. In many cases sand grains and fragments of shells from the bottom of the lake can be found together with the eggs.

Newly hatched larvae rest on large yolk sacs, which disappear when the larvae reach a size of 11 mm. The young leave the mouths of the parents after reaching 12 mm total length and start independent lives in schools.

The eggs in the mouth are well protected and have the advantage of being well supplied with water rich in oxygen. It is unknown to what degree mouthbreeding is necessary for the normal development of the eggs. Experiments carried out in May, 1950 on the eggs of *Tilapia galilaea* and *Tristramella simonis simonis* and again in May, 1951 on the eggs of *Tristramella simonis simonis* have shown that the fertilized eggs taken from the mouth of a fish may continue to develop in a dish or a jar filled with lake water. It is possible that some of the eggs or larvae dropped by the breeding fish caught in the nets survive, and finish their larval development outside the mouths of their parents. This may prove to be important from the point of view of practical fishing in the lake and it deserves thorough examination.

It is interesting to note that successful experiments in rearing eggs and larvae of *Tilapia* under laboratory conditions were carried out by the East African Fisheries Research Organization (Anon. 1955).

The fish do not feed during the mouth breeding period. Liebman (1933) suggested that some of the eggs are swallowed by the breeding fish and serve as food to supply the needed energy. No significant difference, however, has been observed between the number of eggs and the number of advanced larvae counted from the mouths of breeding fish, so we lack evidence of a decrease in the number of offspring during the breeding. Moreover, comparison of the weight of *Tilapia galilaea* in the months before the beginning of spawning season and at the end of the season shows clearly a loss in weight of the breeding fish. At the same time the fat which was present in the abdominal cavity around the guts disappears after spawning.

2. *Age determination and rate of growth*

a. Examination of otoliths

The age was determined from the otoliths of 462 fishes. The otoliths removed from the fish were preserved dry in tubes or envelopes.

For age determinations the otoliths were submerged in methyl salicylate or xylol and their concave surfaces were examined against a black background by reflected light. Under magnification of from twenty to thirty times, it is easy to discern translucent concentric rings which are distinguished from the white opaque bands (Figure 7). Each ring represent a year's growth and thus the number of rings in the otolith corresponds apparently to the age of the fish.

The arrangement of rings shows that during the first and second year the increase

in body length is greater than during the subsequent ones. This is indicated on t otolith by the considerable distance between the first ring and the center and t even greater distance between the second ring and the first. The other rings, situat near the edge of the otolith, are closer together and correspond to the later yea when the growth of the fish is not so rapid.

The translucent rings are probably formed in winter. The formation of rings o the rim of the otoliths and scales in many fish caught in winter may be taken evidence of this. It should, however, be pointed out that a small number of fish co lected in autumn (September, October and November) show also the annual ri on the rim of their otoliths and scales.

b. Examination of scales

Scales used for age determinations were taken from the anterior part of the bo at some distance behind the gill opening. In this region the scales are large and ea to read, but even those from other parts of the body show the annual rings clear

The scales are cycloid and similar in general pattern to those of *Tilapia zillii* a described by Daget (1956). The annuli appear on the posterior part of the scale as series of distinct concentric grooves, more widely spaced and more deeply inscrib than the neighbouring circuli. The first annual ring near the focus is usually not a clear as the following rings.

Scales of several species of Tilapia from East Africa were examined for ring form tion by Holden (1955) and a correlation has been found between ring formation a gonad maturation in *Tilapia variabilis* and *Tilapia esculenta*.

Regenerated scales are of no value for age determination as their annuli ar circuli are partially obliterated.

Scales appear on young fish, 11–12 mm total length, at approximately the tim they leave their parents' mouths.

c. Study of length frequencies

The measurements of the length of *Tilapia galilaea* were taken in February and March 1950, and March 1951. Altogether 2296 fish were measured.

The mesh-size of the fishing nets used limits the catch to fish over 18–19 cm tota length. The measurements taken for this study include, therefore, only fish of larger size.

The total lengths of the fish were measured to the nearest half centimeter. Th data are shown in Figure 1, where three modes are seen, which correspond to th age groups as calculated from otoliths and scales. The first mode represents fis in the 20–22 cm length group and corresponds to the second age group; the secon mode, the 27 cm length group corresponds to the third age group; the third mod includes fish of 31–33 cm total length and probably corresponds to the fourth an fifth age groups. Fish of zero age group are not represented in the diagram, as the are too small to be caught with the equipment used in Lake Tiberias.

d. Fish culture in artificial ponds

Tilapia galilaea was raised in ponds from May 1950, to April 1951 (Ben-Tuvia an

Hofenberg 1951). The young which were hatched in ponds at the beginning of the spawning season (May) reached 14–16 cm by November, while those born later grew only to 5–10 cm.

The variation in the size of the zero age group in Lake Tiberias also may be accoun-

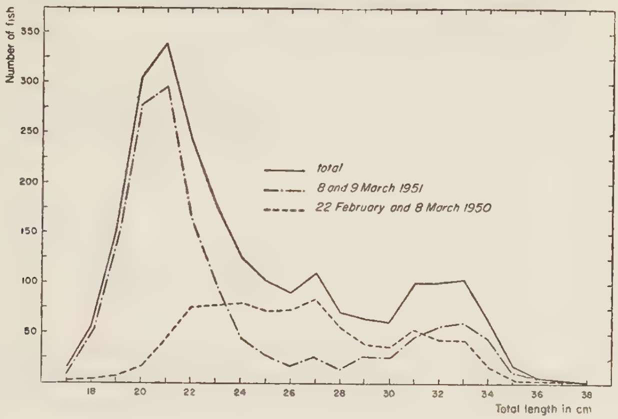

Figure 1
Length frequency distribution of samples of *Tilapia galilaea* from Lake Tiberias

ted for by the long reproductive period. Fish 5–19 cm long, which were collected during the winter months, had one annual ring on their otoliths and scales.

The fish culture experiments proved that the formation of the winter marks on the otoliths and scales occurred in the ponds at the same time as in the lake.

The growth rate of *Tilapia galilaea* was determined by means of the otoliths and scales of 193 males and 185 females, which in almost all cases showed the same number of annuli. It was also noted that some of the flat bones e.g. opercle, preopercle and hypural show also annual zones. Lowe (1952) used the opercular bones for age determinations of cichlids from Lake Nyasa. The age of each fish was determined according to the number of annuli, and the average length for each age group was calculated.

TABLE VI

Mean total length for males and females of *Tilapia galilaea* *collected from February to May* 1950 *and* 1951.

Age	Male			Female		
groups	Number of fish	Range of lengths	Mean length (in mm)	Number of fish	Range of lengths	Mean length (in mm)
I	50	50–190	138	50	50–200	140
II	48	170–270	227	41	160–270	224
III	31	250–310	274	33	240–290	265
IV	18	280–350	315	12	270–330	291
V	20	310–350	325	29	350–290	310
VI	21	340–370	341	16	320–330	323
VII	5	350–360	353	4	320–340	329

The rate of growth of *Tilapia galilaea* in Lake Tiberias seems to be more rap than the rate of growth of the same species in Naussa Hydrodrome near Alexandri in Egypt (Jensen 1958).

The growth rate of males is more rapid than that of females. According to th data in Table 6 and figure 2, small differences in growth rate appear in the secon

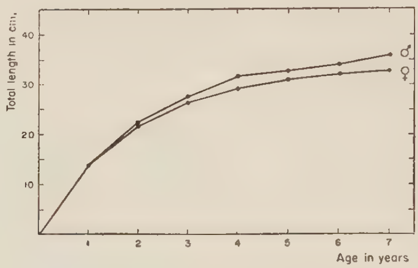

Figure 2
The growth rate of *Tilapia galilaea* as determined from scales and otoliths of fish collected duri February to May 1950 and 1951 from Lake Tiberias.

year which increase in the third and fourth years. The large fish, those above 33 total length, are mostly males, while females of this size are quite rare.

e. Age and size at first maturity

The size of *Tilapia galilaea* at first maturity was investigated by Ricardo-Bertra (1944) and found to be 18 cm total length. My data confirmed her results. Both th males and females began to spawn after reaching 18–22 cm. Only a few ripe fish we found to be less than 22 cm long. Among 125 specimens found with eggs in th mouth, only 8 were between 18–22 cm (6.4%). Age determination of fish of this si show that they become sexually mature at the end of their second year of life.

3. *Weight-length relationship*

A knowledge of the changes in the weight-length relationship is of great importan as these changes indicate fluctuations in the condition of the fish in different seaso or years. The data for this study were taken from examination of 722 specimen caught in Lake Tiberias during most of the months of the year. Each fish was weighe to the nearest gram, and its total length measured to the nearest half centimetre.

It is known that the weight of a fish varies approximately in proportion to th cube of its length. This relationship can be expressed mathematically by the formul $W = KL^3$, where W represents the weight, L, the length and K a constant peculi to any one species.

From this formula the constant K^1 was calculated for the fish caught from th the first of January to the end of May and the results were compared with the consta K^2, calculated for the fish obtained during June, July and August.

$K^1 = 0.02249$

$K^2 = 0.02086$

The two constants were determined by the method of least squares for fish in the range of 20 to 35 cm.

By comparison of the two values of K the conclusion may be drawn that the fish are in better condition during the months preceding the spawning season and at its beginning (January-May) than during the latter months of spawning (June-August).

It has been determined that the weight does not change exactly as the cube of the length of the fish but that the formula is $W = KL^x$. The constant K and the power x have been calculated for the fish caught in all months except June, July and August. The correct formula was found to be: $W = 0.00001687\ L^{3.087}$

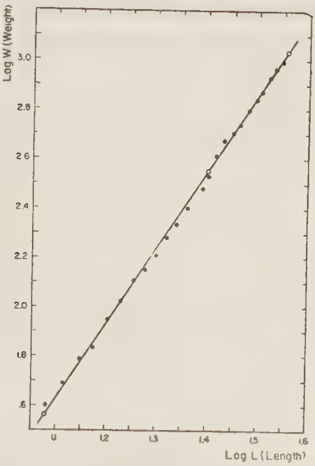

Figure 3
Plot of logarithm of length against logarithm of weight for *Tilapia galilaea*

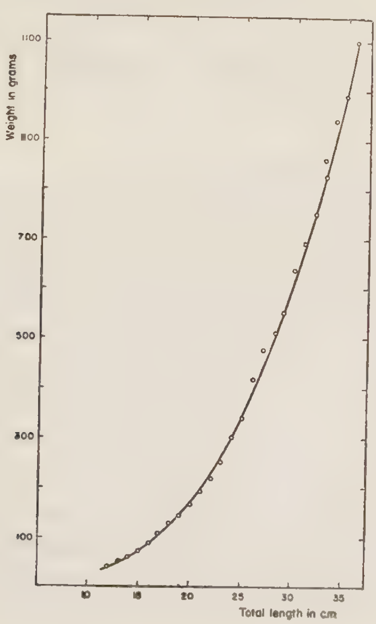

Figure 4
Plot of length against weight for *Tilapia galilaea*

Figure 3 is a graphic representation of the relationship between the log weight and the log length. The straight line in this graph which fits approximately to the data has been drawn from the formula: $\log W = -1.773 + 3.087 \log L$. It is interesting to note that the average weights of *Tilapia galilaea* for each size group in the Lake of Tiberias are much lower than the corresponding average weights of the same species in the area of Niger (Monod 1949).

4. *Total and standard length relationship*

Not only the total length but also the standard length of *Tilapia galilaea* was measured on 113 specimens of 105–360 mm total length, to the nearest half cm. The relationship between the total and the standard lengths has been calculated according to the formula: $S = a + bT$, where S represents the standard length, T, the total length, a, a constant, and b the factor that determines the increase of the standard length in relation to the increase of the total length. The result obtained by the method of least squares is $S = 0.76 + 0.83\,T$, and is graphically represented in Figure 5.

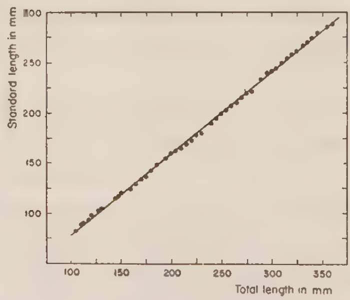

Figure 5
Plot of total length against standard length for *Tilapia galilaea*

5. *Feeding habits*

26 specimens from Lake Tiberias were examined.

The digestive tract of *Tilapia galilaea* is very long, folding several times in the abdominal cavity and showing little regional differences in its external shape. At the end of the short esophagus there is a small stomach which apparently serves for the digestion of the coarse particles of food. According to Greenwood (1953) the stomach of *Tilapia esculenta* contains gastric glands which apparently enable it to carry out the initial stages of digestion. The intestine is very long and shows no external variations. The relationship between the length of the gut and the length of the fish changes greatly with the size of the fish; in young fish the intestine is short in proportion to the body (varying from 1.1 : 1 to 1.2 : 1), while in adult fish the length of the gut is many times larger than the size of its body (varying from 6.0 : 1 to 8.2 : 1).

It should be noted that in the stomach of five very young specimens (11–21 mm length) the zooplankton, Copepoda and Cladocera, were found to be most abundant; phytoplankton was represented in small quantities only. Large fish, however, feed

TABLE VII
Relation of length of the gut to the length of the body of Tilapia galilaea

Total length of fish (in mm)	Length of gut (in mm)	Ratio of gut length to body length	Mean ratio of gut length to body length
10–22	11–39	1.04–1.77	1.38
25–29	64–100	2.50–3.50	3.06
45–50	180–205	3.85–4.40	4.04
290–360	2100–2800	6.30–8.20	7.66

principally on plankton among which microscopic algae and especially *Peridinium westi* are prevalent. The alimentary tract of the fish examined contained almost all forms of the plankton characteristic of Lake Tiberias during the same season (Komarovsky 1951 and 1959).

Similar feeding habits have been describeed by Gauthier-Lievre (1949) who gives a detailed list of microscopic plants found in the intestines of *Tilapia galilaea* and *Tilapia nilotica* from Niger.

The presence of different kinds of algae in the alimentary canal does not necessarily meant that all of the them are utilized by the cichlids. According to Fish (1951), the colonies of blue-green and green algae pass undigested through the alimentary canal of *Tilapia esculenta*, with the diatoms, only, being fully digested.

As was mentioned above, the fish feeds most intensively during the period from February to May. A thick layer of fat then accumulates around the gut. This fat disappears later during the reproductive season.

The gut of breeding fish is usually empty and only in the posterior part of the digestive tube is it possible to trace remnants of food consumed by the fish before spawning. In a few cases cichlid larvae were found in the stomach pouch of the fish. They were apparently swallowed by the breeding fish when caught in the net.

Tilapia nilotica Linne

This fish is known in this country by two common names: Amnon hayaor (Hebrew); Musht lubbad (Arabic).

The distribution of *Tilapia nilotica* extends over most of the African continent (Trewavas 1937). The northern limit of the distribution of the species is its Asiatic extension in Palestine. This fish is common in Israel and appears in almost every lake and river of the country. It was even found in the isolated springs of Ein Feshkha (Steinitz 1951b).

Tilapia nilotica is not very abundant in Lake Tiberias and appears in much smaller quantities than *Tilapia galilaea*. On several occasions between February 1950 and March 1951 the number of *Tilapia nilotica* and *Tilapia galilaea* was counted in the commercial catch and the percentage relation between the two species was established. The results are given in Table VIII, showing that the percentage of *Tilapia nilotica* varied from 1.9 to 7 with an average of 3.9.

TABLE VIII

The quantitative relationship between Tilapia nilotica and Tilapia galilaea.

Date	*Tilapia galilaea* Examined specimens	*Tilapia galilaea* Percentage	*Tilapia nilotica* Examined specimens	*Tilapia nilotica* Percentage
22.2.50	825	97.4	22	2.6
23.2.50	259	97.4	5	1.9
8.3.51	600	95.8	26	4.2
9.3.51	603	95.0	32	5.0
18.3.51	239	93.0	18	7.0
Total	2526	96.1	103	3.9

Tilapia nilotica caught in Lake Tiberias were on the average smaller than *Tilapia galilaea*. The maximum total length of the former was 32 cm although the average length was generally between 18 and 24 cm. In many lakes of tropical Africa the opposite is the case; *Tilapia nilotica* is much more common and grows to a greater length than *Tilapia galilaea*. In Lake Edward and Lake George, for example, they reach 46 cm and in Lake Rudolf 64 cm (Worthington 1932).

Tilapia nilotica is characterized by its great vitality; after being removed from the water it remains alive longer than any other species of Cichlidae.

1. *Reproduction*

The spawning season of *Tilapia nilotica* starts at the end of March or the beginning of April and probably lasts until the end of May. In the subsequent months no ripe females were observed, although the scarcity of examined specimens (35 during June-September) does not permit any final conclusion as to whether or not reproduction continues during June and July.

Tilapia nilotica, like most cichlids found in Israel, is a mouthbreeder. The behaviour of the spawning pair in the brackish water of Lake Quarun in Egypt was described by Boulenger (1901). According ts this author the male, which is larger than the female, digs a pit on the bottom and the female deposits her eggs there. The fertilized eggs are then taken into the mouth of the female and bred. The two mouth-breeding fishes, described by Liebman (1932) were also females.

In the present work the six fish found with eggs in their mouths were all females. This seems to indicate that the male does not generally participate in mouth breeding.

Males seem to be more common in Lake Tiberias than females. The ratio is 1.64 to 1. Among the 132 fishes investigated, 80 were males and 52 females. The proportion is different in Lake Edward in Africa, where the females seem to be more abundant than the males and the ratio is 1 : 1.6 (Worthington 1932).

The number of eggs in the ovaries of specimens from 22 to 25 cm total length was 2100–4300. The eggs are smaller than those of *Tilapia galilaea*; in ripe specimens their diameters were: length 2.50–2.96 mm and width 2.10–2.25 mm.

According to Lowe (1955 b) the size of young fishes in mouth does not exceed 3.4 mm.

Drawings of larvae of *Tilapia nilotica* 5 to 8 mm long from Niger are given by Monod (1949).

The number of eggs in the mouths of six females of length 22–31 cm which were xamined was between 120 and 730 for each fish. The fish probably eject some of heir eggs when caught by the net, so it may be assumed that the number of eggs red by a single female is usually higher. Liebman (1933) counted 1300 eggs. Worthing-on (1929) found a female with 2000 eggs in her mouth in Lake Albert.

Tilapia nilotica spawns for the first time when it reaches 18–20 cm. When kept n ponds it may spawn at a smaller size. "Dr. Worthington remarked that in a shallow agoon of Lake Albert, the *Tilapia nilotica* were maturing at a much smaller size han in the Lake itself" (Hickling 1950).

Otoliths and scales of 120 fish were examined for age determination. The growth ate of *Tilapia nilotica* appears to be almost as fast as that of *Tilapia galilaea* (Tables I and IX). The difference in mean length for the various age groups is 6–36 mm. ike in the other species of Cichlidae the males grow faster than the females.

Scales of *Tilapia nilotica* from Noussa Hydrodrome near Alexandria, Egypt, were sed by Jensen (1958) for back calculations. The average rate of growth thus obtained very similar to the rate of growth of the same species in Lake Tiberias. Jensen 958) also found that the yearly ring is formed between January and April. This also eems to be true for cichlid fish in Israel (see chapter on *Tilapia galilaea*).

Feeding habits

Examination of the stomach contents of eleven fish from 15 to 24 cm in length hows that the food of *Tilapia nilotica* is composed mostly of plankton. In the fish ollected during February and March the gut was especially full of phytoplankton onsisting of Peridineae (mostly *Peridinium westii*), Protococcales (*Pediastrum*, *cenedesmus*), Desmidiaceae (*Staurastrum*, *Spondylosium*), Diatomeae (*Synedra*, *avicula*, *Surirella*, *Melosira*, *Cyclotella*). Zooplankton, mostly Copepoda, was bserved in comparatively small quantities.

The stomachs and intestines of the fish collected during June and July contained uch less food. The number of *Peridinium westii* was small while the quantity of gher plants had increased. Worthington (1932 and 1929) reported that the food of *ilapia nilotica* in the lakes of Central and East Africa also consists of plankton.

A list of phytoplankton found in the alimentary canals of the same species from ourao, Niger, is given by Gouthier-Lievre (1949). The most common organisms ere *Cosmarium elipsoideum* (*Zygnemaceae*), *Lyngbya circumcreta*, *Anabaena sphaerica* d *Anabaenopsis raciborskii* (Hormogonales), *Surirella dida*, and *Melosira granulata* acillariophyceae).

The alimentary tract of *Tilapia nilotica* is very long (Pellegrin 1903). The adult fish, –25 cm, examined in the present study had a gut length 8.0–9.4 times the length the body.

TABLE IX

Age frequencies of *Tilapia nilotica* *according to length groups as determined from otoliths o*
67 males and 53 females

Length groups (in mm)	Age of males in years I	II	III	IV	V	Age of females in years I	II	III	IV	V
80–89	2					1				
90–99	3					4				
100–109	2					1				
110–119	1									
120–129						1				
130–139						1				
140–149	1									
150–159	1						1			
160–169		1					1			
170–179		5					5			
180–189		4					2			
190–199		4					2			
200–209		2					3			
210–219		4					3	2		
220–229		3	1				2	2		
230–239		1	5				1	2		
240–249		1	5				1	4		
250–259		1	2					3		
260–269		1	2	1				1	1	
270–279			2					1	1	
280–289			2	1					1	
290–299			1		1				1	2
300–309			1	3	1				1	1
310–319				1	1					1
Total	10	27	21	6	3	8	21	15	5	4
Mean length (in mm)	108	203	256	297	305	104	197	242	285	302

Tilapia zillii Gervais

This fish is known in this country by two common names: Amnon hamatzuy (Hebrew) Addadi (Arabic).

Tilapia zillii, like the two previously mentioned species of the same genus (*Tilapia galilaea* and *Tilapia nilotica*), is widely distributed in lakes and rivers of Africa (Boulenger 1915). In certain places in the Belgian Congo *Tilapia zillii* is the most abundant species, being kept also in ponds. (Huet 1957). In East Africa this species was introduced to many dams and ponds of Uganda and Kenya (Lowe 1955a). In Israel, *Tilapia zillii* is often found in ponds as an intruder causing damage in carp culture (Yashouv 1958).

Tilapia zillii is very common in Israel and is found in almost all inland waters. In Lake Tiberias it is plentiful along the shore in shallow water. In the commercial catch the fish appear mostly in the summer months and are caught in large numbers near Migdal.

It is interesting to note that thousands of *Tilapia zillii* were found dead or half dead on the sea shore between Ceaserea and Hedera in December 1952; they were apparently swept out to the sea after heavy rains and floods when many streams had overflown.

. *Reproduction*

Tilapia zillii is the only cichlid in Israel which is not a mouthbreeder. In no single instance among hundreds of specimens examined during the reproductive season was a fish observed with eggs in the oral cavity. It appears that the description of this pecies as a mouthbreeder by Liebman (1933) was caused by an erroneous determination of the fish. Many authors (Daget 1952, Lowe 1955, Greenwood 1957) who have investigated *Tilapia zillii* in the African lakes and rivers found this species to be guarder and not a mouthbreeder.

An interesting observation on breeding habits of *Tilapia zillii* was made by Zarka 1956) who found that 30 days after the first spawning the pair started its second pawning and the author was able to follow three broods. According to the same uthor the eggs hatch after 74 hours and after 5 days the young begin to move in chools. Dr. Mendelsohn of the University of Tel-Aviv obtained several broods f *Tilapia zillii* in aquariums and found that the development of the eggs takes 24–28 ours (personal communication).

Daget (1952) found that the eggs of *Tilapia zillii* hatch after 48 hours; four later days he young start to swim freely and the yolk sac has almost disappeared.

The male can be distinguished from the female by his vivid colours and large size. Both sexes take care of their young, lead the school and fight approaching alien fish.

It may be concluded that the reproductive period starts in May and continues at east until the end of July or even later, since during this period ripe females were ound in Lake of Tiberias. During the period May-July fry which had been recognized s *Tilapia zillii* by the fact that they were accompanied by adult fish were collected. Daget (1956) found that in central Niger basin *Tilapia zillii* reproduce from April o September.

An attempt was made to determine the number of fry in a school belonging to one pair of fish. The young were caught by a dip-net and counted. The total number of ry in one school was 470, and 530 in another. The young, of 9 mm total length were already without yolk-sac.

The number of eggs in the ovaries is much greater, females of 14–18 cm total ength carrying from 1700 to 4100 eggs. The eggs are fairly small, 1.1–1.6 mm in diameter. Lowe (1955b) found that the number of eggs produced by *Tilapia zillii* ange from 1000 to 5711, depending upon the size of the parent fish.

. *Age and rate of growth*

The females begin to spawn for the first time after reaching 13–14 cm total length. According to personal information obtained from Prof. K. Reich of the Hebrew

University, *Tilapia zillii* of a smaller size spawns in ponds. Lowe (1955a) found that in overcrowded ponds the fish breed when only 7 cm long. In Lake Tiberias, this fish reaches 13–14 cm length after two years of growth.

The length of twenty-eight fish was determined, ranging from 8.0 to 26.5 cm total length. Among them were only four specimens from 8–16 cm. Most of the fish were from 17 to 22 cm and it appears that only males reach a size larger than this. Because of the scarcity of specimens, the growth rate was calculated for males and females together.

TABLE X

Mean total length of Tilapia zillii according to age groups

Age groups	Number of fish	Mean length in mm
I	2	100
II	1	145
III	3	171
IV	9	190
V	8	191
VI	3	208
VII	2	245

The relationship between the growth of the fish and its scales was used to determine the mean length of the fish at the end of each year of its life. The distance from the centre to each annular ring was measured on otoliths and scales and the mean length of the fish computed for each age group.

The data in Table XI shows the difference between the results obtained from scales and otolith measurements. The disparity is considerable for the first and second year groups, diminishing gradually in the subsequent years. The small quantity of material examined is not sufficient to establish whether the scales or the otoliths are more reliable for back calculations of rate of growth.

TABLE XI

Totallength of Tilapia zillii corresponding to the formation of each annulus, calculated from measurements on scales and otoliths of 20 fish.

Age groups	Mean length according to scales (in mm)	Mean length according to otoliths (in mm)
I	56	76
II	102	122
III	144	153
IV	163	170
V	175	177

The alimentary tract of the six specimens which were examined contained plankton and many particles of higher plants. In the stomach of one female, seven young cichlid fish were found.

Buxton (1922) examined the stomach and intestine contents of 31 specimens of *Tilapia zillii* from Kishon marshes near Haifa, from Nahr Barideh near Jaffa and from Beisan. He found diatoms, grit and copepods in all of them. Most of them contained also filamentous algae. Among some specimens Volvocales, Ostracods, Vorticellids, jumping Rotifers, pieces of grass, Cladocera, small Nematocerous larvae, Chironomidae, Hydrachnids, and other insects were found. The same author writes "to summarise these results one may say that *Tilapia zillii* takes a wide range of food, animal and vegetable."

Lowe (1955a) found this species "useful for controlling weeds in dams as it feeds largely on aquatic vegetation".

Tristramella simonis simonis (Gunther)

This fish is known in this country by two common names: Amnon Shimon (Hebrew); Marmur (Arabic).

The genus *Tristramella* is endemic for Palestine and Syria (Trewavas 1942). *Tristramella simonis simonis* is very common along the shores of Lake Tiberias, but does not appear in schools as does *Tilapia galilaea.*

1. *Reproduction*

The spawning lasts from April until the end of August. Examination of the ovaries' especially of mouthbreeding females during various months of the year shows that the adult fish spawn at least two or three times during a season. Females with eggs or larvae in the oral cavity have in many cases fully developed ovaries.

Lortet (1875) and Tristram (1884) reported erroneously that only males are mouthbreeders. Tristram (1884) counted 200 eggs in the mouth of a male. It is very probable that the observations were made not on *Tristramella simonis simonis* of Lake Tiberias but on a different form of *Tristramella* characteristic of Lake Huleh where both male and female are mouthbreeders. The drawing of *Tristramella simonis* in his paper (plate 17) pictures quite clearly the sub-species from Huleh. He thought the two forms identical and wrote that they are "restricted to the little lakes of Gennesaret and Huleh".

Bodenheimer (1927) examined 42 mouthbreedig fish from Lake Tiberias and they were all females. Of the 116 fish from Lake Tiberias examined during the present investigation, three (2.6 %) were breeding males and 113 (97.4 %) were females.

TABLE XII

Participation of females and males of Tristramella simonis simonis in mouthbreeding

Month	Females	Males	Total
April	3	1	4
May	6	1	7
June	76	1	77
July	26	–	26
August	2	–	2
	113	3	116

According to these data it seems to be obvious that males do not participate t any great extent in mouthbreeding. The three mouthbreeding males were found i April, May and beginning of June only. These months are the breeding season o *Tristramella simonis intermedia* which appear occasionally in Lake Tiberias. It possible that some specimens of this subspecies were collected in the lake and examine under the name of *Tristramella simonis simonis*. In July and August only *simoni simonis* continues to spawn and at this time of the year no breeding males were foun in Lake Tiberias.

The females generally become mature at the beginning of the third year of life.

The number of ripe eggs in the ovaries is related to the size of the fish, being greate in large fish than in small ones.

The eggs in the ripe ovaries of *Tristramella simonis simonis* were counted individuall and their number ranged from 480 to 760.

TABLE XIII

Number of eggs in ovaries of Tristramella simonis simonis according to size of fis

Total length (in cm)	Number of specimens examined	Average number of eggs
16.5	1	480
17.0	3	675
17.5	3	660
18.0	3	705
18.5	3	760

The ripe eggs are oval shaped and large. Their diameters are given in Table XIV.

TABLE XIV

Diameter of ripe eggs of Tristramella simonis simonis

Length (in mm)		Width (in mm)	
Range	Average	Range	Average
3.50–4.05	3.78	2.24–3.42	2.85

It appears that there is not enough space in the mouth of a fish for all the eggs laid. Not more than 228 eggs were found in the oral cavity of any fish examined. It may be pointed out that there was no singificant difference observed beween the number of eggs and the number of larvae carried by different breeding females. A high number of larvae was found in two fish which were 185 mm long; in the first case 219 young larvae of 12–13 mm were found and in the second case 195 of the same size.

Lortet (1875) reported that by extending the lower jaw the volume of the oral cavity of the fish is increased during the breeding period.

2. *Age and rate of growth*

Otoliths and scales of *Tristramella simonis stmonis* were examined in the same way

as those of *Tilapia galilaea*. The age of 117 fish, ranging from 11 to 22 cm total length was determined. No specimens larger than 22 cm were observed during the present investigation. Fish larger than this are probably very rare in Lake Tiberias.

The growth rate of the fish is rapid in the first three years of life; in the following years the growth rate is much slower. There are also differences in the rate of growth of males and females; the average length of males at the end of each growth year is higher than that of females (Table XV).

Small fish belonging to the zero and first year groups are not represented in the collected material. The supplementary data on growth rate was obtained by measuring scales and otoliths and calculating the mean length of the fish at the time of the formation of year rings. Scales and otoliths of 24 fish, 12 males and 12 females, were examined and the results given separately according to sex in Table XVI. The difference between the back calculations and the direct age determination (Table XV) is caused by the fact that the majority of the fish used for actual age determination was caught during May, June and July, some months after the formation of the winter ring on scales and otoliths.

TABLE XV

Age frequencies of Tristramella simonis simonis according to length groups as determined from otoliths of 29 males and 90 females

Length groups	Age of males						Age of females					
(in cm)	I	II	III	IV	V	VI	I	II	III	IV	V	VI
11.0–11.9						2						
12.0–12.9							1					
13.0–13.9						1						
14.0–14.9	1						1					
15.0–15.9	3						2					
16.0–16.9	1	1					1	4	1			
17.0–17.9		1					1	16	1	2		
18.0–18.9		1	1					12	15	8	2	1
19.0–19.9			1		1			2	7	5	3	
20.0–20.9		1	5	3	2							1
21.0–21.9			3	2	1						1	
22.0–22.9			1									
Total	5	4	11	5	4	3	6	34	24	15	6	2
Mean length	15.4	18.2	20.6	21.0	20.4	12.1	15.4	17.8	18.6	18.8	19.4	19.4

A comparison of the results shows that the mean length of the first three year age groups computed from otoliths is always higher than that computed from scales.

3. *Feeding habits*

Of the 12 specimens examined, ten were caught during June-July and two at the beginning of February. The food observed in the digestive tract of the summer sample

TABLE XVI

Total length of Tristramella simonis simonis corresponding to the formation of each annulus calculated from measurements on scales and otoliths of 12 males and 12 females.

Age	Mean length of males (in mm) Otoliths	Scales	Mean length of females (in mm) Otoliths	Scales
I	77	70	77	74
II	140	128	125	117
III	173	170	161	156
IV	189	188	174	179
V	193	193	185	186

was not abundant. It consisted of Diatomeae, Protococcales and Desmidiaceae. Zooplankton was represented by Copepoda and Cladocera (*Bosmina longirostris*). Many particles of higher plants were found also. The presence of sand grains and mud in the intestine indicates that in many cases the fish were feeding near the bottom.

The digestive tracts of the fish collected in February were filled with food, mostly phytoplankton.

Tristramella sacra (Gunther)

This fish is known in this country by two common names: Kdashnun (Hebrew) Kelb (Arabic)

Tristramella sacra is rare in Lake Tiberias and was unknown in Lake Huleh (Steinitz 1951a).Tristram (1884) wrote that "it has not been found either in Lake Huleh or in the stream of the Jordan itself". Liebman (1933) is probably mistaken in his description of this species from Lake Huleh.

This fish can easily be distinguished from the other cichlid species by its monocuspid teeth, the big mouth cleft and the very prominent lower jaw.

Its importance in lake fishing is slight. It never appears in the commercial catch in large quantities, but is more abundant from February until June than in the other months. The size of the fish in the catch is usually from 18–23 cm. The largest fish found during this study was 27.2 cm total length and weighed 300 grams.

During the present investigation only 46 specimens were examined. The results may contribute some preliminary information to the biology of this species.

1. *Reproduction*

The spawning period of *Tristramella sacra* begins in April and lasts until the end of June. Tristram (1884) observed a male, in June, carrying fry in its oral cavity. Of the seven mouthbreeding specimens examined in the present study four were females and three males. We can, therefore, conclude that both sexes participate in mouthbreeding.

The number of eggs or larvae carried by a single specimen is from 60 to 220. The young are kept in the mouth of the parent until they reach the comparatively large size of 14.5 mm length.

The ripe ovaries of fish from 21–24 cm total length contained from 800–1170 eggs. The diameters of the eggs were measured and the averages calculated; length – 3.5 mm, width – 2.6 mm.

. Age and rate of growth

Otoliths and scales of 18 specimens from 17 to 27.5 cm long were examined. The results of age determinations are given in Table XVII for males and females together. It appears that the rate of growth is rapid during the first two years and slower in the following years.

TABLE XVII

Mean total length of Tristramella sacra according to age groups.

Age groups	Number of specimens	Mean length in mm
III	2	180
IV	7	210
V	7	220
VI	1	245
VII	1	275

. Feeding habits

The food of *Tristramella sacra* consists mainly of plankton. During the period from February to April the fish feed mostly on *Peridinium westii* and other microscopic plants.

Several scientists described this species as the single predator among the Palestine cichlids (Tristram 1884, Masterman 1909, Ricardo-Bertram 1944). This view should be corrected on the basis of the present examination of stomach contents. A single fish was found in the gut in only two cases: an *Aphanius* sp. (Cyprinodontidae) about 4 cm long in a fish 24 cm long and remnants of *Acanthobrama* sp. (Cyprinidae) in a fish 220 mm long. Except for this the intestine was full of phytoplankton.

The digestive tube of *Tristramella sacra* is quite long, about 2–3 times as long as the body. This indicates the ability of this fish to exploit plant food, as is the case with the other cichlids.

Tristramella simonis intermedia (Steinitz and Ben-Tuvia)

This fish is known in this country by two common names: Amnon hahuleh (Hebrew); Okar (Arabic)

This fish differs morphologically from *Tristramella simonis simonis* of Lake Tiberias (See Key). Trewavas (1942) pointed out that five fish examined by her showed deviations from the typical form of *Tristramella simonis*. Some of their features related them to *Tristramella magdaienae*, which is known in the vicinity of Damascus. The differences lead to the establishment of three subspecies (Steinitz and Ben-Tuvia, in press).

Tristramella simonis intermedia were collected on three trips to Lake Huleh; 10

specimens in October, 1950, 46 specimens in April, 1951, and 64 specimens in Jul 1951.

1. *Reproduction*

The spawning season probably begins in spring and lasts until June. Accordin to information received from fishermen the fish begin to breed in March. All fis examined in Hulatah in April were in some state of reproduction; some carrie young in their mouths, others were ripe and ready to spawn.

Mouthbreeding specimens were examined and their sex determined. Eight of them were males and seven females. Undoubtedly both sexes participate in mouthbreeding. This is one of the most prominent biological differences between *Tristramella simoni simonis* of Lake Tiberias and *Tristramella simonis intermedia* of Lake Huleh.

The April sample of 46 fish was made up of 23 females and the same number of males (ratio 1 : 1). Similar results were obtained from examination of 22 fish caught on July 11, 1951, 10 being females and 12 males, (ratio 1 : 1.2).

The mean length of males is greater than that of females. According to the Apri sample (fish from 18–22 cm total length) the average size of males was 20.6 cm and of females, 19.2 cm.

2. *Age and rate of growth*

The age of 61 fish ranging from 9 to 23 cm was determined.

The data presented in Table XV shows that the Huleh species grows faster than *Tristramella simonis simonis* of Lake Tiberias. It may be that the food in Lake Huleh is more plentiful as the gut contents of the July sample show a great deal of plankton while, during the same period, the guts of the Tiberias fish were half empty.

The growth rate of fish was established by actual age determinations and by back calculations of the length of the fish according to the measurements of the year rings on the otoliths (Table XVIII and XIX).

The figures obtained by the two methods do not contradict each other; the actual age determinations are based on fish caught in April and July. Mean lengths obtained by this method were higher than those calculated by the retroactive method, since about six months elapsed from the time of the winter ring formation.

The rate of growth, as in other local cichlid fish, is more rapid for males than for females.

The exploitation of this fish in Lake Huleh was rational and economical. The fish were caught after reaching 17–18 cm (120–130 grams in weight) at the end of the second or the beginning of the third year of life. Fish of this size are ripe and ready to spawn. They probably reach their first maturity at 14–15 cm length, like *Tristramella simonis simonis*, the related subspecies from Lake Tiberias.

3. *Feeding habits*

Ten specimens from 17–22 cm total length were examined. In all the fish the

TABLE XVIII

ge frequencies of Tristramella simonis intermedia according to length groups as determined from otoliths and scales of 36 males and 28 females.

ength groups (in mm)	Age of Males 0	I	II	III	IV	V	Age of Females 0	I	II	III	IV
›0–99	1										
›0–109	1										
·70–179										1	
·30–189			4	4					8	4	
·90–199			5	1						4	1
·)0–209				8					1	6	2
·10–219				6	2						1
·20–229				3		1					
otal	2	—	9	22	2	1			9	15	4
verage	100		190	206	215	225			187	195	205

TABLE XIX

otal length of Tristramella simonis intermedia corresponding to the formation of each annulus calculated from measurements on otoliths of 52 fish

Age groups	Mean length in mm Males	Females
I	144	133
II	180	168
III	197	188

limentary tract was full of food, consisting mostly of phytoplankton. Among the ooplankton occurred Rotatoria, eggs of Crustacea and a few specimens of Copepoda nd Cladocera. In the stomach of one specimen, 20 cm long, remnants of Cyprinid sh were found.

Key to the Cichlids of Israel

he key has been prepared from systematic measurements on collected specimens and from relevant terature. A systematic description of the cichlid species and their synonyms can be found in the apers of Boulenger (1915), Regan (1922), Trewevas (1942), and Greenwood (1957). The key is repared for specimens larger than 9 cm standard length.

1. Dorsal fin with 27 to 31 spines and rays.
 2a. 18 to 24 gill rakers on the lower part of the anterior arch.
  3a. Depth of preorbital bone is larger than the lower jaw and contained 3.5 to 4.3 in length of head; lower pharyngeal bone heart-shaped (Figure 8G); no dark transversal streaks on the caudal fin. .. .. *Tilapia galilaea*
  3b. Depth of preorbital bone is smaller than the lower jaw and contained 4.5–5.1 in length of head, Lower pharyngeal bone of triangular shape (Figure 8F); caudal fin with dark wavy transversal streaks. .. .. *Tilapia nilotica*
 2b. 8 to 9 gill rakers; mouth horizontal; lower pharyngeal bone covered with compressed teeth, some of which are tricuspid (Figure 8b); lower lip of a light colour. .. .. ..*Tilapia zillii*
b. Dorsal fin with 23 to 26 spines and rays.
 2a. 9 to 12 gill rakers on the lower part of the anterior arch; lower pharyngeal bone with at least two rows of enlarged teeth in the middle; no yellow spots on the anal fin.

3a. Teeth in jaws monocuspid; interorbital width 4.1–4.6 in length of head; lower jaw distinct prominent; mouth very oblique. .. .. *Tristramella sac*

3b. Teeth bicuspid or tricuspid; interorbital width 3.1 to 3.8 in length of head.

4a. Lower jaw not prominent; interorbital width 3.1 to 3.5 in length of head and great than the length of the lower jaw; common in Lake Tiberias, not known in Huleh .. .. *Tristramella simonis simon*

4b. Lower jaw prominent; interorbital width 3.3. to 3.8 in the length of head and small than the length of the lower jaw; common in Lake Huleh, rare in Lake Tiberias. .. .. *Tirstramella simonis intermed*

2b. Gill rakers 7; lower pharyngeal bones with a group of enlarged teeth in its posterior pa (Figure 8 A and a), usually 1 to 10 yellow spots on anal fin; no white ringed dark ocellus on th soft dorsal fin*; fish small, not larger than 120 mm standard length *Haplochromis flavii-josep*

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* All other cichlids have a dark ocellus on the soft dorsal fin when young.

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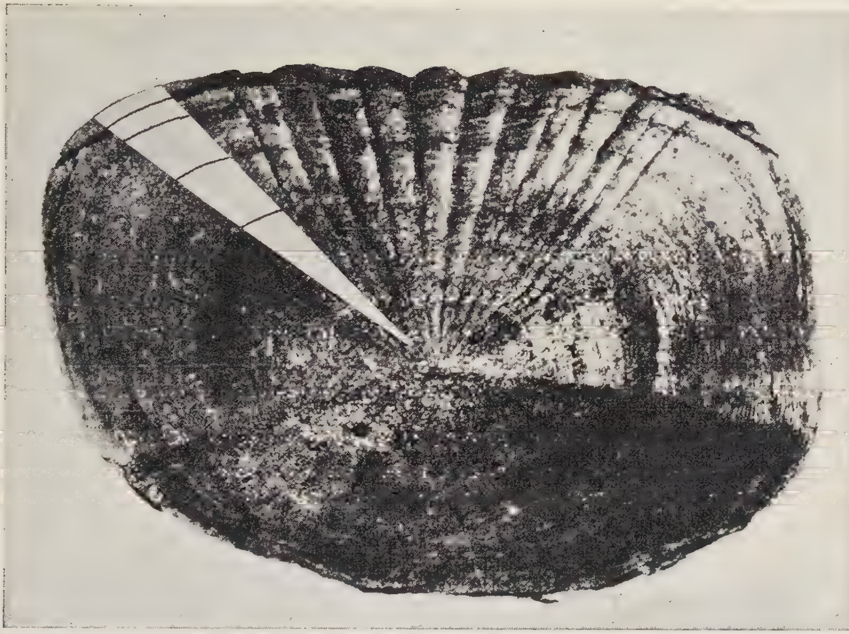

Figure 6
Scale of *Tilapia galilaea* showing five annuli. Total length of fish 320 mm.

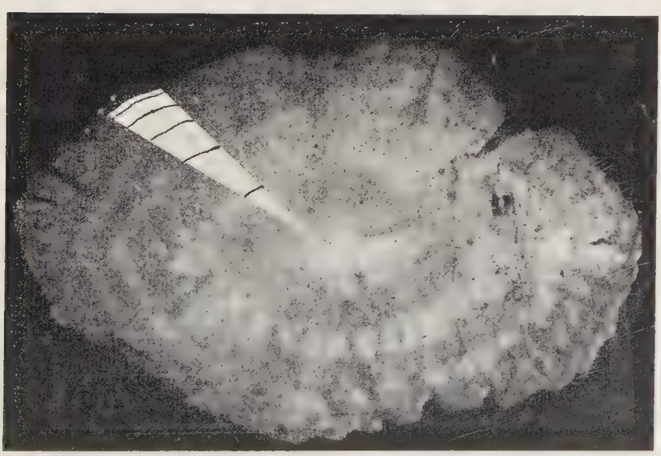

Figure 7
Otolith of the same fish as in figure 6 showing five annuli.

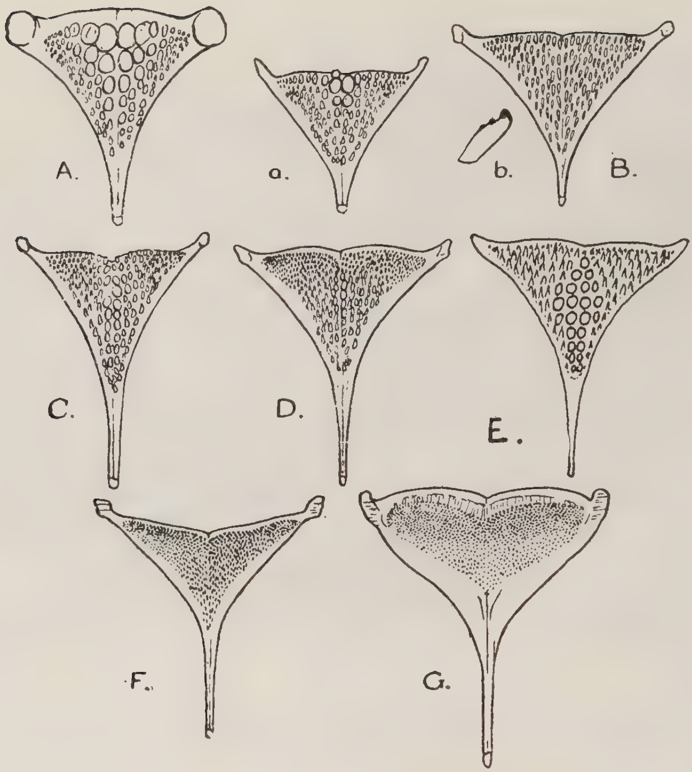

Figure 8

Lower pharyngeal bones of A, *Haplochromis flavii-josephi*, male, 68+15 mm; a, the same, female, 60+13 mm; B, *Tilapia zillii*, 145+38 mm; C, *Tristramella sacra*, 145+31 mm; D, *Tristramella simonis*, 142+37 mm; E, *Tristramella simonis intermedia*, 170+45 mm; F, *Tilapia nilotica*, 155+43 mm; G, *Tilapia galilaea*, 160+40 mm; b. a single pharyngeal tooth of *Tilapia zillii* further enlarged.

A, a, B, b, C, D, F, and G are reproduced from Trewavas (1942). The drawing of the pharyngeal ones of *Tristramella magdalenae* marked E in the original figure of Trewavas has been replaced by a drawing of pharyngeal bones of *Tristramella simonis intermedia* from Lake Huleh. D has the bme form as the lower pharyngeal bones of *Tristramella simonis simonis* from Lake Tiberias.

Figure 9

Tilapia galilaea (Artedi)

Figure 10
Tilapia nilotica (Linné)

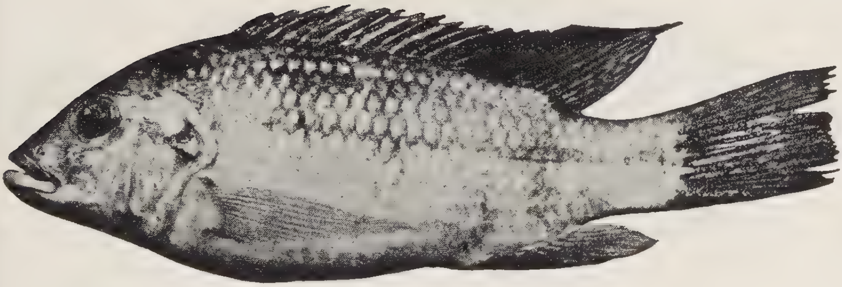

Figure 11
Tilapia zillii Gervais

Figure 12
Tristramella sacra (Günther)

Figure 13
Tristramella simonis simonis (Günther)

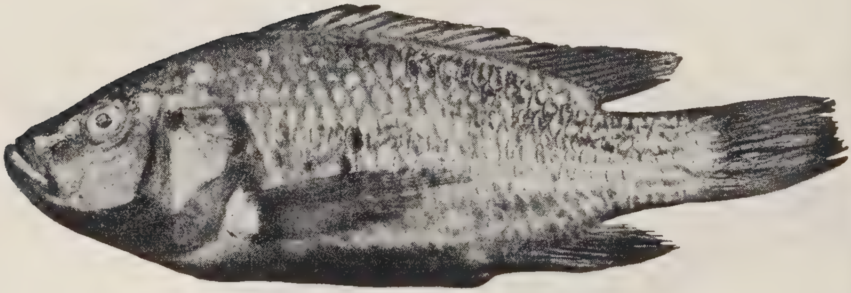

Figure 14
Tristramella simonis intermedia (Steinitz and Ben-Tuvia)

Figure 15
Haplochromis flavii-josephi (Lortet).
Male, 82 mm

A NEW SPECIES OF *OLYNX* FORSTER (HYM. EULOPHIDAE) FROM ISRAEL

R. R. Askew, B. Sc.

Hope Department of Entomology, University Museum, Oxford

ABSTRACT

During an examination of the species of *Olynx* in the British Museum (Natural History), I came upon specimens of a hitherto undescribed species, collected in Israel.
Olynx **albipes**; n. sp. is described, and its relationships to other members of the genus are indicated.

Olynx **albipes** n. sp.

Female (figure 1) : Head and thorax dark bronze-green, scutellum with two parallel, longitudinal, blue lines, and a median, indefinite, bronze line in the anterior half. Clypeus fuscous. Flagellum fuscous dorsally, paler beneath; scape testaceous; pedicel with a metallic green spot dorsally. Coxae concolorous with thorax; trochanters fuscous; femora bronze-green basally, almost white apically; tibiae almost white or very pale yellow, with a fuscous streak on flexor aspect of front tibiae; tarsi white with fuscous claws. Gaster shining bronze-green, blue-green on first segment. Forewings with two fuscous marks, one at proximal end of marginal vein, the other beneath stigma. Length 2.8 – 3.6 mm.

Antenna (figure 3) with all funicle segments longer than broad, the first about 2.3 times as long as pedicel; club barely wider than first funicle segment, and 1.5 times length of third.

Scutellum with a shallow, median, anterior groove. Middle tibial spur nearly as slong as outer edge of first tarsal segment. Middle and hind tibiae with white bristles only. Forewing (figure 2), ratios marginal vein: stigmal vein as 2.5 : 1 (mean of 8 pecimens with limi ts 2.18 and 2.40); speculum open below.

Gaster ovate, rather longer than thorax and nearly twice as long as wide. Only extreme apices of ovipositor sheaths visible from above.

Male: less bronzed, wings with smaller fuscous marks, scape fuscous, tibiae and tarsi pale yellow. Colouring in other respects similar to female. Length 2.5 – 2.9 mm.

Antenna funicle clothed in short, white, recumbent hairs, the first segment deeper than the second, the last segment shorter than the fourth (figure 4).

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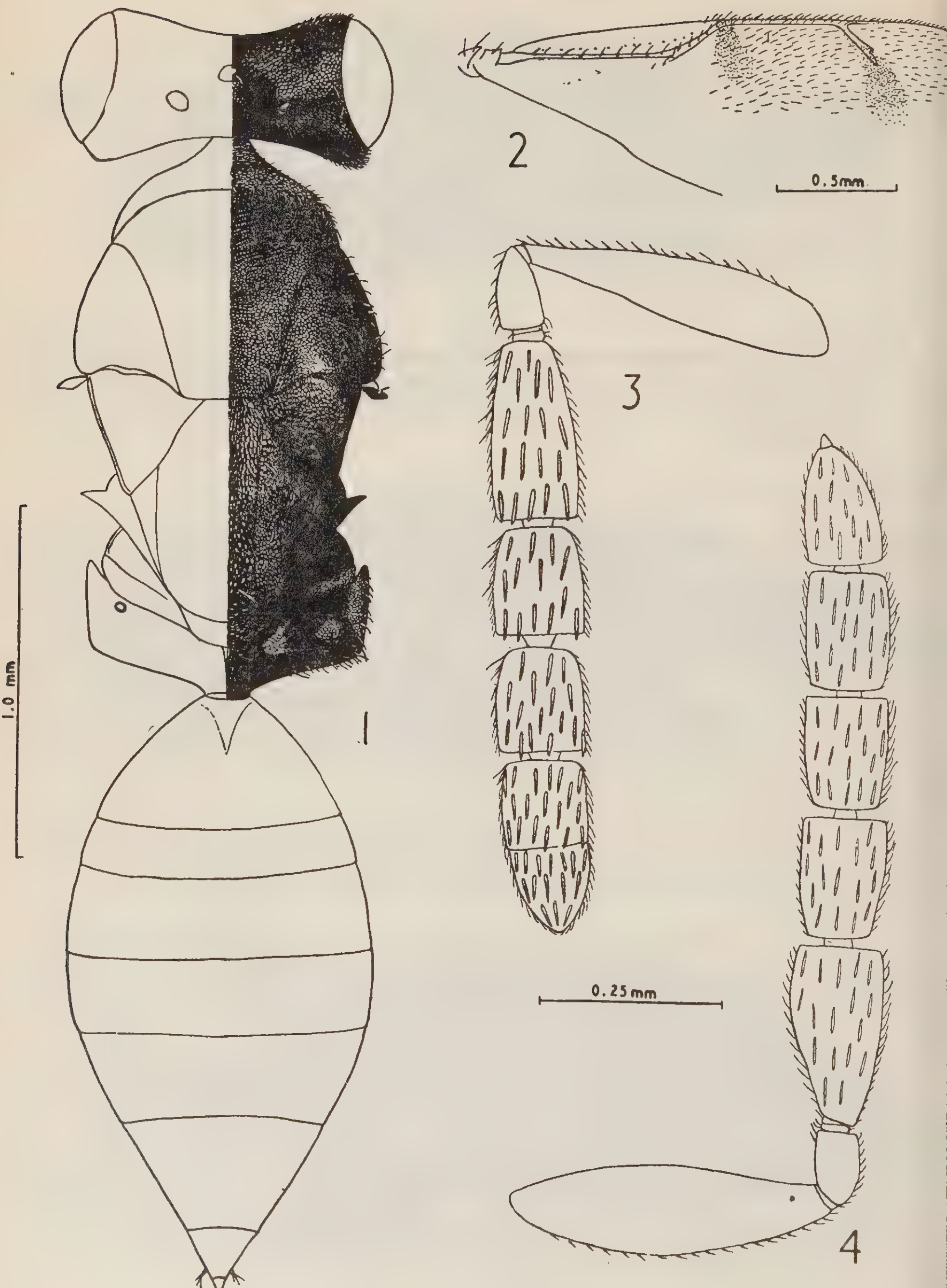

Figures 1–4
Olynx **albipes** n. sp. 1. Body of ♀; 2. Forewing of ♀; 3. Antenna of♀; 4. Antenna of ♂.

Specimens examined: — ISRAEL: Tivon, labelled "Ex *Quercus ithaburensis* L.," 7 females and 7 males, 24.I.1955 and III. 1955 and 1956. Mr. J. F. Perkins informs me that Dr. M. Sternlicht is the donor of these specimens; ISRAEL: Pardess Hanna, "On *Quercus*" 1 female and 1 male, III. 1936 (S. Duvdevani).

Holotype: ♀, Tivon, Israel, III. 1955 (M. Sternlicht), also labelled "B. M. 1956–190" and "G. S590". I have labelled the rest of the specimens from Tivon as paratypes. The holotype will be returned to the British Museum (Natural History) together with 9 paratypes. The remaining 5 paratypes will be deposited in the Hope Department of Entomology, Oxford, and in my personal collection.

Quercus ithaburensis L. (= *Q. aegilops* L. var. *ithaburensis*) evidently has a very restricted range, being recorded only from Israel, Syria and Sinai. *Olynx* **albipes** will almost certainly be found to be a parasite of some gallforming Cynipid on this tree.

This species belongs to the *O. gallarum* species group (Askew 1959), characterised by an open speculum on the forewing, the absence of a discoloured line behind the ocelli between the eyes, and the presence of two fuscous marks on the forewings of the females. In my key, the female of the present species would run to the *O. trilineata-O. euedoreschus* couplet. The following key will separate it from these two species:

1. Tibiae and tarsi golden yellow or yellow. Gaster rarely as much as 1.5 times as long as wide and about equal to, or shorter than, length of thorax. Flagellum shorter, less than width of head (ratio 1:1.12). Hind tibiae with a few longitudinal lines of short, black bristles.
.. .. *O. trilineata* Mayr, *O. euedoreschus* (Walker).

2. Tibiae and tarsi almost white or very pale yellow. Gaster nearly twice as long as wide, and longer than thorax. Flagellum longer, usually equal to width of head. Hind tibiae with white bristles only.
.. .. *O.* **albipes** n. sp.

The males would run to the *O. gallarum-O. trilineata* couplet, from which species *O.* **albipes** may be separated as follows: —

1. First funicle segment shorter, length less than 1.5 times width. Tibiae and tarsi deeper yellow.
.. .. *O. trilineata* Mayr, *O. gallarum* (Linnaeus).

2. First funicle segment longer, length greater than 1.5 times width, often more than twice width. Tibiae and tarsi paler yellow or white.
.. .. *O.* **albipes** n. sp.

ACKNOWLEDGEMENT;

I wish to thank Dr. M. W. R. de V. Graham for his helpful advice during the preparation of this paper. I am also indebted to Mr. J. F. Perkins for permission to examine

the British Museum (Natural History) material, and to Mr. A. F. Dyer for botanica information.

This work was carried out whilst in receipt of a grant from the Department o Scientific and Industrial Research.

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LETTER TO THE EDITOR

3acteria-free cultures of ***Eudorina elegans*** **Ehr.,** M. LASMAN*, *Department of Zoology, The Hebrew Jniversity of Jerusalem*

\xenic cultures of protozoa[1] facilitate the study of their physiology inasmuch as they render the ulture medium controlable and eliminate any untoward effects which may be caused by the presence of bacteria. Experiments were therefore made in order to obtain bacteria-free cultures of *Eudorina legans* as a prerequisite to the investigations of the physiology of this flagellate.

Eudorina elegans — Phytomonadina (collected by Mrs. A. Rotberg of the Department of Botany n a small rain-pool near Jerusalem), was cultivated in Benecke's nutrient solution of 0.05% con- entration with the addition of 2 p.p.m. of "Oxoid" liver extract.

In the first stage, several clones starting from single colonies were isolated. The best growing train was then transferred to a series of 150 ml Erlenmeyer-flasks, and all further experiments were arried out on cultures orginating from it. The cultures were kept at 22–24°C and illuminated by uorescent light for 14 hours daily.

In order to purify the cultures, the following agents were used: sulphanilamide, sulphathiazole, enicillin, streptomycin, synthomycetin (chloramphenicol), and aureomycin[2,3,4]. At the beginning, series of experiments was carried out in order to establish the maximum concentration of the gents in which *E. elegans* can survive. In each experiment 10 ml of the culture was transferred to 0 ml sterilized nutrient solution, and the various agents in a given concentration were added. The ollowing concentration limits of survival were found: sulphathiazole 0.1–0.2 mg/ml, sulphanilamide .1 – 0.2 mg/ml, penicillin 1250–2500 units/ml, aureomycin 0.01–0.02 mg/ml, synthomycetin 0.1–0.2 ıg/ml, streptomycin 0.1 – 0.2 mg/ml.

The harmful effect of high concentrations of the agents on *E. elegans* constituted the main difficulty ı obtaining bacteria-free cultures.

Of the antibiotics used, streptomycin appeared to be the most harmful to *E. elegans*, due to its ɔochlorotic effect[5]. In all subcultures, the cells quickly lost their colour and disappeared after 3–7 ays. For this reason a mixture of different antibiotics in gradually increasing concentrations was sed. It is possible that this method caused, by the way of natural selection, the appearance in the ıltures of a strain partially resistant to antibiotics. It may be assumed that the appearance of such strain finally resulted in the normal development of bacteria-free cultures.

In experimental series which lasted 3 months (from 23. III until 23.VI.58), the cultures were ıbmitted first to the action of sulphanilamide in a concentration 0.1 mg/ml. Thereafter, sulphathiazole, 2 mg/ml, was used in two transfers. The cultures developed well, but still contained bacteria. Sub- ıltures were therefore submitted to the action of penicillin, 1000 units/ml, and afterwards to the llowing mixture of agents: synthomycetin 0.2 mg/ml, sulphathiazole 0.2 mg/ml, and penicillin i00 units/ml. After 24 hours in the solution, 10 ml of the cultures were transferred to a sterile ıtrient solution. It was found, however, that after these treatments the cultures still contained ıcteria. After 7 days of additional growth the cultures were again submitted to the action of another ixture of the following agents: synthomycetin 0.2 mg/ml, sulphathizole 0.2 mg/ml, penicillin i00 units/ml, and aureomycin 0.02 mg/ml. After further 24 hours, 10 ml of the cultures were trans- rred to a sterile nutrient solution and grown at 22°–24°C for 10 days. Thereupon 10 ml of culture us obtained were transferred to 50 ml fresh Benecke solution and five new sub-cultures were origina- d. These cultures were found to be finally free of bacteria and from them subsequent axenic sub- ltures were grown.

* This research has been carried out with the aid of a grant from the Immigrant Absorption epartment of the Jewish Agency.

eceived February 9, 1959

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I am most grateful to Professor K. Reich for encouragement and help in accomplishing this work.

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THE GENETICS SOCIETY OF ISRAEL

The Genetics Society of Israel (formerly the 'Genetics Circle') was founded in 1958. The purpose of the Society is the advancement of the Science of Genetics in Israel. Its various activities promote the cooperation and exchange of views among gengticists in Israel.

Of the eight conferences held up to the present, four took place during the era of the 'Genetics Circle'. The different institutions engaged in genetics research take turns in arranging the programes of these meetings. Field trips to the various research stations in applied genetics are being organized from time to time.

Since last autumn members have paticipated in the seminars arranged by the genetics teachers of the Hebrew University, in Jerusalem. This is a further indication of the cooperation between the various institutions.

Spininess in Ricinus — a character determined by a mobile morphogenic factor

Hava Stein, *Plant Genetics Section, The Weizmann Institute of Science, Rehovot*

Pteridine patterns of *Drosophila* organs in the presence of position effects for eye-colour genes

N. Bloch, *Department of Zoology, The Hebrew University of Jerusalem*

Pteridine patterns in various organs of flies carrying position effects for the eye-colour genes *bw* and *w* were compared with homozygotes for the corresponding point mutations and with wild type. The position effect produces drastic changes of pteridine concentrations not merely in the eyes, but also in Malpighian tubules, testes and of ovaries.

Pteridine levels in the presence of the position effect are not generally intermediate between those of the mutant and the normal. This finding excludes an interpretation of the position effect as a mutational change in a fraction of the cell population of each organ.

The hybrids *Pm/bw* contain fluorescent substances, in concentrations which are intermediate between those of the parental strains, while the hybrids w/w^{m4} exhibit heterosis in the pteridine levels of several organs.

Biochemical variation in flies of normal phenotype

Elisabeth Goldschmidt, *Department of Zoology, The Hebrew University of Jerusalem*

Since quantitative differences in the concentrations of the fluorescent pteridines are held to be useful characteristics in Insect Taxonomy, the range of their intraspecific variation deserves attention. The present communication deals with intra-populational differences in pteridine levels.

Each of a series of isogenic stocks derived from a wild population of *Drosophila melanogaster* presents a different pattern of pteridine content in several organs investigated. The pteridine levels in hybrids are generally intermediate as compared with those of the two parental lines, but some cases of heterosis were observed.

Fertility in first-cousin marriages*

A. RONEN, T. COHEN AND N. BLOCH, *Department of Zoology, The Hebrew University of Jerusalem*

The fertility in couples of different Jewish communities was estimated by a) the number of births during a given period after marriage, and b) the interval between marriage and the birth of the first child. The fertility of first cousins was not inferior to that of unrelated couples.

In a community of Kurdish Jews, fertility was also estimated by the rate of abortions and stillbirths per pregnancy. This index, too, did not reveal any adverse influence of consanguinity on fertility.

In populations living under different social conditions a marked decrease in the fertility of first cousin marriages has been reported.

Rheumatic heart disease, thalassemia and glutathione instability in children of Jews from Kurdistan**

T. COHEN, M. A. SZABO, Y. MATOTH, A. ADAM, E. THEODOR AND E. GOLDSCHMIDT, *Department of Zoology, The Hebrew University of Jerusalem*; *Kupat Cholim, Jerusalem*; *Hadassah University Hospital, Jerusalem*; *Government Hospital, Tel-Hashomer*

The incidence of RHD among the children in a settlement of Kurdish Jews amounted to 10 % in the age group 6–13 years and to 6 % among all 620 children examined.

While the frequency of the thalassemia gene is estimated at 1/8, the incidence of glutathione instability exceeds 60 %. There is no familial or individual association between RHD and the two erythrocyte defects, both of which are randomly distributed among the various families.

Hematological data will be presented for 33 persons affected simultaneously with thalassemia and glutathione instability. These findings indicate that the glutathione defect does not enhance the anemia, while glutathione stability is slightly improved in the presence of thalassemia.

Chromosomes of primitive snakes from Israel

Y. L. WERNER, *Department of Zoology, The Hebrew University of Jerusalem*

Previous workers[1,2] have examined the karyotypes of 23 ophidian species from among ca. 2500 living forms. 14 of these, belonging to various families, have an

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* Work supported by a Ford Foundation grant to Dr. E. Goldschmidt.

** Work supported by a Ford Foundation grant.

identical karyotype of $2n = 10\text{ V} + 6\text{ I} + 20\text{ m}$ ($2n = 36$). Two of the metacentric chromosome pairs are larger than any others in the set; one of these has unequal arms. The rod-shaped pairs vary from acrocentric forms to submetacentric ones. It is hard to discern the shape of the microchromosomes. The remaining species show small deviations from this formula.

As already pointed out by Bellairs and Underwood[3], the above does not prove this formula to be primitive in snakes, since all the species examined belong to "advanced" families: Colubridae Aglypha, Colubridae Opisthoglypha, Elapinae, Hydrophiinae, Viperinae and Crotalinae.

In the present study representatives of three "primitive" families have been examined. Preparation of acetic-orcein squash-preparations was preceded by "pretreatment" with hypotonic saline[4].

Leptotyphlops phillipsi (Leptotyphlopidae): All the 3 males examined exhibit the formula $2n = 10\text{ V} + 6\text{ I} + 20\text{ m}$. The set looks very much like the "common opidian karyotype".

Typhlops simoni (Typhlopidae): The only male obtained shows a karyotype of $2n = 10\text{ V} + 6\text{ I} + 16\text{ m}$ ($2n = 32$), thus lacking 2 pairs of microchromosomes as compared to the "common ophidian karyotype".

Eryx jaculus (Boidae): The one male examined had a karyotype of $2n = 8\text{ V} + 8\text{ I} + 18\text{ m}$ ($2n = 34$). Two of the smallest chromosomes each bear a satellite.

Whether these formulae are typical of the families represented cannot be ascertained before more species are examined. However, if the Leptotyphlopidae are regarded as the most primitive snakes[3], the hypothesis that the formula $2n = 10\text{ V} + 6\text{ I} + 20\text{ m}$ is basic in snakes gains support. On scanning the literature on saurian karyotypes[1,5] it becomes evident that of over 40 species (belonging to 16 families) examined only one has a similar karyotype: *Varanus gouldi* ($2n = 8\text{ V} + 8\text{ I} + 24\text{ m}$). The set closely resembles that of snakes. This tends to support the prevailing theory that the ancestors of snakes were related to the platynotid lizards[3].

I am grateful to Professor E. Goldschmidt and Dr. J. Wahrman for helpful interest and to Dr. H. Mendelssohn, J. H. Hoofien, P. Amitai and S. Blauschild for specimens of snakes.

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ex–chromosomes in beetles

)RA FREUND, *Department of Zoology, The Hebrew University of Jerusalem*

hromosomal polymorphism in populations of mammals

. ZAHAVI. *Department of Zoology, The University of Tel Aviv*

ytological analysis of mammalian hybrids

. WAHRMAN, *Department of Zoology, The Hebrew University of Jerusalem*

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BULLETIN
OF THE RESEARCH COUNCIL OF ISRAEL

Section B
ZOOLOGY

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INDEX

TO

VOLUME 8B

INDEX

TO

VOLUME

8 B

CONTENTS

Number 1, March 1959

Number 2, June 1959

Number 3, September 1959

Number 4, December 1959

PROCEEDINGS

OF THE

GENETICS SOCIETY OF ISRAEL

First session, Tuesday morning 20.10.1959

Chairman: *M. Taran*

AUTHOR INDEX

SUBJECT INDEX

יוצא לאור ע״י
מוסד ויצמן לפרסומים במדעי הטבע ובטכנולוגיה בישראל
המועצה המדעית לישראל – משרד החנוך והתרבות – האוניברסיטה העברית בירושלים
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